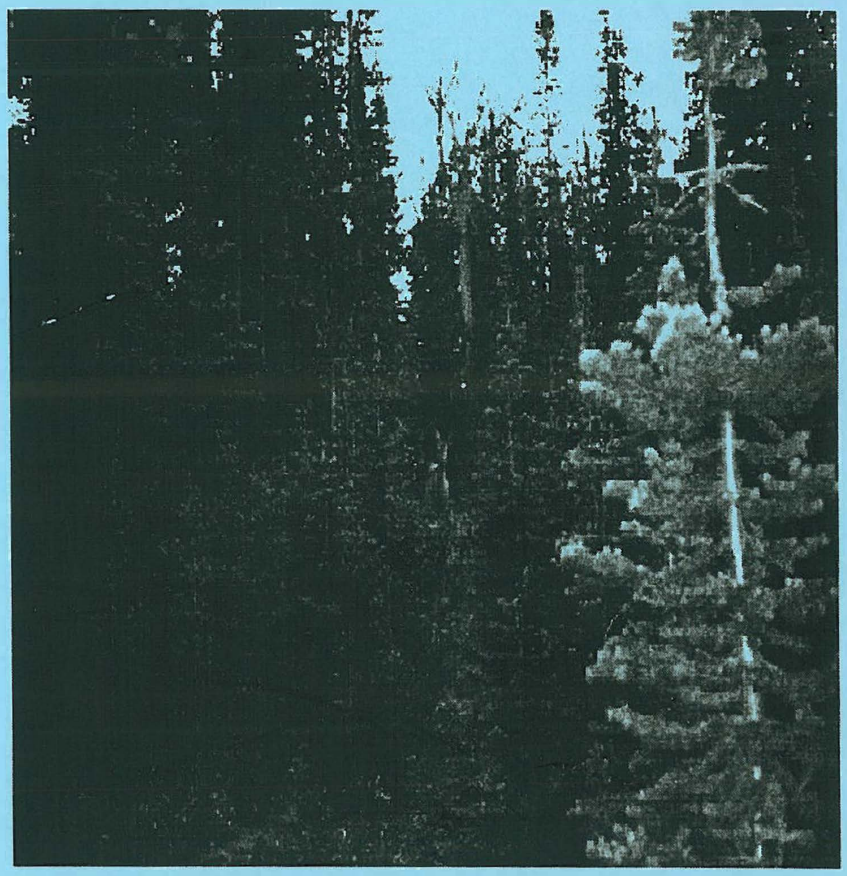
United States Department of Agriculture

Forest Service

Northern Region

Forest Health Protection

Montana



Report 99-2

Montana Department of Natural Resources and Conservation

Forestry Division

Forest Insect and Disease Conditions and Program Highlights - 1998

Montana

Forest Insect and Disease Conditions and Program Highlights

1998

Report 99-2

May 1999

Prepared by:
Tim McConnell, Northern Region, Forest Health Protection

Contributors:
Ken Gibson, Blakey Lockman, Nancy Sturdevant, Jane Taylor, Don Berg, Gary Little, Bob James, Sandy Kegley, Carol Randall, Northern Region, Forest Health Protection; Steve Kohler, Montana Department of Natural Resources and Conservation, Forestry Division

Data summary and map production:
Larry Stipe, Northern Region, Forest Health Protection

Text edits:
Linda Hastie, Northern Region, Operations Support Group

TABLE OF CONTENTS

INTRODUCTION 1

SUMMARY OF CONDITIONS 1

ANNUAL AERIAL SURVEY 1

Figure 1. Areas of 1998 Coverage Aerial Detection Surveys 3

INSECTS 5

Bark Beetles 5

Table 1. Bark beetle infested acres, 1994-1998 5

Summary Of Bark Beetle Conditions 5

Douglas-fir Beetle (DFB) 6

Spruce Beetle (ESB) 8

Fir Engraver (FE) 8

Pine Engraver (IPS) 8

Mountain Pine Beetle (MPB) 8

Western Balsam Bark Beetle (WBBB) 9

Western Pine Beetle (WPB) 9

Table 2. Douglas-fir beetle-infested acres in Montana, all ownerships, from 1995 through 1998 10

Table 3. Acres of mountain pine beetle-caused mortality on state and private lands in Montana from 1995 through 1998 11

Table 4. Acres of mountain pine beetle-caused mortality on Federal ownership in Montana from 1995 through 1998 12

Table 5. Bark beetle infested acres (other than mountain pine beetle and Douglas-fir beetle) in Montana 13

Figure 2 - Areas of Douglas-fir beetle infestations in Montana,1998 15

Figure 3. Areas of mountain pine beetle infestations in Montana (all host species) 1998 17

Figure 4. Areas of subalpine fir mortality caused by western balsam bark beetle and other agents in Montana, 1998 19

Defoliators 21

Western Spruce Budworm 21

Douglas-fir Tussock Moth 21

Larch Casebearer 21

Gypsy Moth 21

Satin Moth 21

Other Defoliators 22

DISEASES 23

General Summary 23

Most Important Diseases 23
Diseases of Local Importance 24
Stem And Branch Diseases 24
Root Diseases 24
Foliage Diseases 25
Specific Disease Reports 25
Root Diseases 25
Annosum Root Disease in Ponderosa Pine 25
Tomentosus Root Disease 25
Foliage Diseases 25
Elytroderma Needle Blight 25
Dothistroma Needle Blight 26
Lodgepole Pine Needle Cast 26
Brown Spot Needle Blight 26
Other Diseases 26
Cottonwood Defoliation 26
Aspen Defoliation 27
Branch Dieback of Whitebark Pine in the Crazy Mountains 27
SPECIAL PROJECTS 27
Insects 27
Douglas-Fir Beetle Project--Flathead NF 27
Engraver Beetle Project--Kootenai NF 28
Developing techniques to monitor insects as agents for biological control of spotted knapweed, evaluating impact and determining optimum site release strategies 29
Evaluating the Use of Pheromones for Monitoring the Establishment of Agapeta zoegana (Lepidoptera: Tortricidae), a Biological Control Agent of Spotted Knapweed 29
Diseases 30
Annosum Root Disease Project on the Flathead Indian Reservation 30
Root Disease in Douglas-fir/Grand Fir Stands 30
Other 31
A Three-year Evaluation of the Effects of Chlorine on Douglas-fir and Ponderosa Pine Trees near Alberton, Montana 31
Limber Pine Evaluation Surveys 31
APPENDIX 33
FOREST HEALTH PROTECTION PERSONNEL 35

COMMON AND SCIENTIFIC NAMES 36
Diseases 36
Insects 36
PUBLICATIONS 38

INTRODUCTION

This report summarizes the major forest insect and disease conditions in Montana during 1998 and was jointly prepared by Forest Health Protection, State and Private Forestry, Northern Region, USDA Forest Service and the Montana Department of Natural Resources & Conservation, Forestry Division. Information for this report was derived from ground and aerial surveys conducted across most of Montana.

SUMMARY OF CONDITIONS

Western Montana showed an increase in Douglas-fir beetle, western pine beetle and mountain pine beetle in lodgepole pine. While the mortality of subalpine fir has decreased on the Beaverhead National Forest in the same general areas, subalpine fir mortality increased substantially on the Gallatin National Forest. Other bark beetle infestation areas remained at approximately the same levels as 1997.

Defoliating insects increased in the summer of 1998, including approximately 500 acres of western spruce budworm light defoliation northwest of Helena on the Helena National Forest and small infestations of tent caterpillar and satin moth. No visible Douglas-fir tussock moth defoliation was observed in the state and no gypsy moths were trapped in the state in 1998. Light larch casebearer defoliation was detected by ground surveys in scattered areas in the far western portion of Montana.

Various foliage needle blights and fungi caused defoliation to cottonwoods, willows and aspen across the state. Ponderosa pine needle blight continues to cause heavy local infections across western Montana. For the third year in a row, whitebark pine has showed severe dieback in localized areas on the Gallatin and Lewis and Clark National Forest. The high levels of larch needle cast dropped dramatically from the 1997 high levels. And lodgepole pine needle cast actually increased in some areas, from the Continental Divide east of Butte to the Bitterroot Divide on the far west.

Mortality and growth losses from root disease and dwarf mistletoes continue to be high throughout the state. Root-disease-caused mortality is more common west of the Continental Divide, although large patches can be found east of the Divide. Dwarf mistletoe continues to cause losses of approximately 33 million cubic feet annually. Douglas-fir western larch and lodgepole pine are the tree species most severely affected.

White pine blister rust continues to be present throughout the range of five-needle pines in the state. Rust severity is highest in the northwestern part of the state where the disease continues to cause extensive mortality in western white pine.

ANNUAL AERIAL SURVEY

The annual aerial detection survey in Montana was conducted from July 6 to August 21, 1998. The survey took approximately 325 aircraft flight hours and covered approximately 23,000,000 acres of mixed ownership forest lands, excluding most wilderness areas. See figure 1, Areas of 1998 coverage during the Forest Health Protection Aerial Detection Survey in Montana. The 1998 aerial survey included three sketch mappers, rather than two in previous years, thus completing the survey in less weeks than previously. Although a wet spring occurred across much of Montana, the months of July and August were drier than normal, making for a good survey season.

Much of the data summarized in this report is a product of the aerial survey, as well as ground surveys and biological evaluations. Along with the data summaries, aerial survey maps are available from the Forest Health Protection Field Office in Missoula, in both paper and digitized GIS format.

The annual aerial detection survey is an overview survey designed to cover large areas in relative short periods of time. Priority forest disturbances include bark-beetle-caused mortality, defoliators and windthrow. If forest disturbance activities are low, secondary disturbances such as diseases, needle casts, high-water damage and previous fire damage are sketch mapped. The survey covers each area once a year during which time the observer sketch maps as many disturbances and damage as possible. The survey is conducted using single-engine, high-wing airplanes, flying at speeds of approximately 90 to 120 m.p.h., at an average altitude of approximately 1,000 to 2,000 feel above ground level, using contour drainage

pattern flying with one observer in each airplane.

The aerial survey data are estimates from airplanes and though not as many areas were ground checked for accuracy as we would like, enough were checked to lend confidence to the areas for which we only have aerial survey data.

Together, aerial and ground surveys provide information relative to bark beetle-caused mortality, as well as other damage agents, pertinent to land managers charged with the responsibility of maintaining forest health.

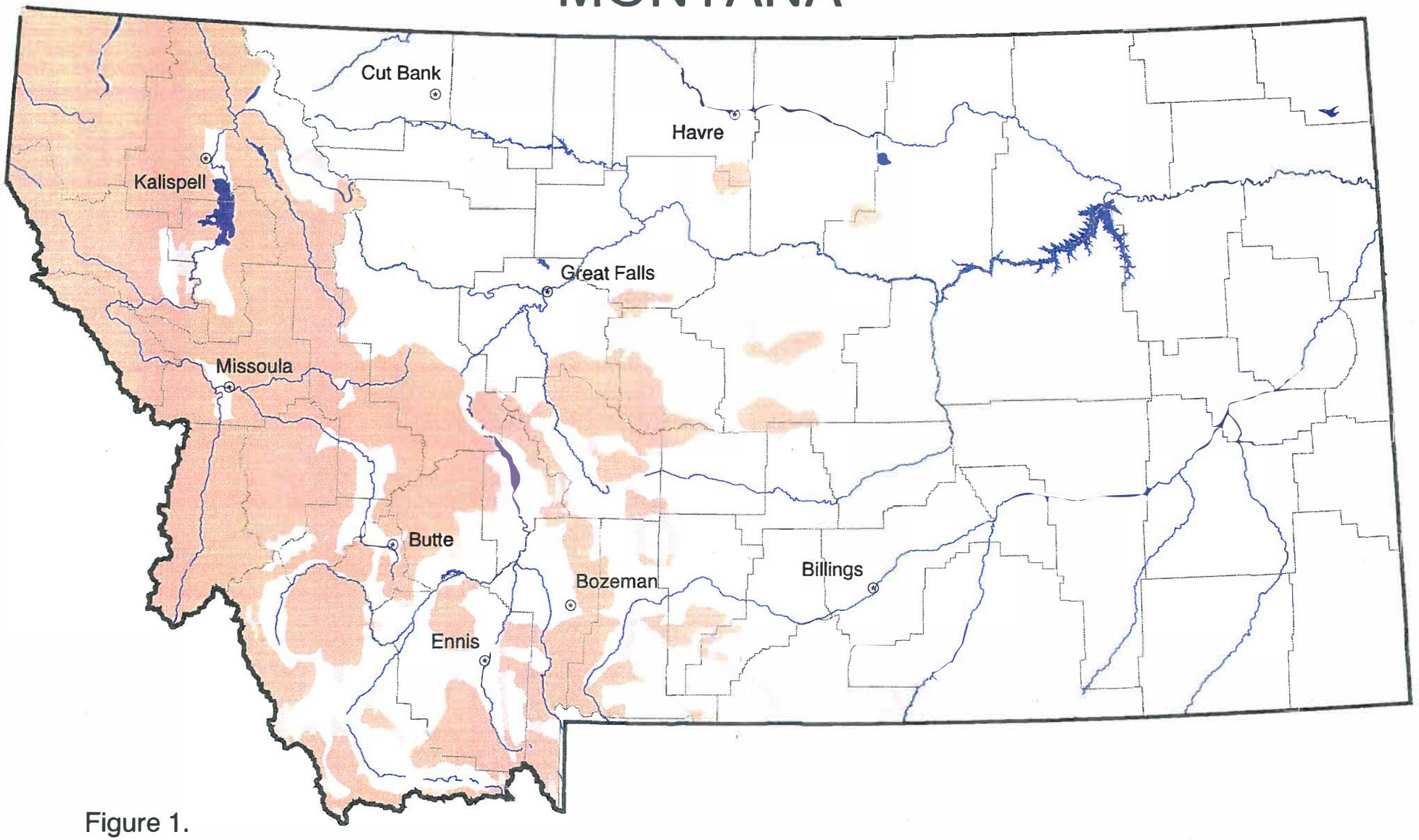


Figure 1.

Areas of 1998 coverage during the Forest Health Protection Aerial Detection Survey in Montana.

INSECTS

Bark Beetles

Table 1. Bark beetle infested acres, 1994-1998

	1994	1995	1996	1997	1998
DFB*	7,194	5,805	4,353	3,955	8,310
ESB	157	767	1,267	1,502	1,995
IPS	1,551	8,220	19	513	698
WPB	985	1,433	1,181	857	1,318
FE	318	349	401	615	523
WBBB	39,292	41,425	44,673	30,088	59,248
MPB	19,195	31,340	27,503	34,187	39,198

***The following abbreviations will be used throughout the report:**

Beetles:	DFB	=	Douglas-fir beetle, *Dendroctonus pseudotsugae* Hopkins
	ESB	=	Spruce beetle, *D. rufipennis* (Kirby)
	IPS	=	Pine engraver, *Ips pini* (Say)
	MPB	=	Mountain pine beetle, *D. ponderosae* Hopkins
	WPB	=	Western pine beetle, *D. brevicomis* LeConte
	FE	=	Fir engraver, *Scolytus ventralis* LeConte
	WB-BB	=	Western balsam bark beetle, *Dryocoetes confusus* Swaine
	RTB	=	Red turpentine beetle, *D. valens* LeConte
Hosts:	LPP	=	Lodgepole pine
	PP	=	Ponderosa pine
	WW-P	=	Western white pine
	WBP	=	Whitebark pine
	DF	=	Douglas-fir
	GF	=	Grand fir
	SAF	=	Subalpine fir
	ES	=	Englemann spruce
Other:	NF	=	National Forest
	RD	=	Ranger District
	IR	=	Indian Reservation
	BLM	=	Bureau of Land Management

Summary Of Bark Beetle Conditions

Despite a dramatic increase in areas infested by DFB in 1998, MPB remained the most expansive and damaging bark beetle pest in Montana. Relatively mild temperatures over the past two winters have contributed to overwintering survival and most bark beetle populations have increased as a result. For DFB, unusually high amounts of wind-thrown and storm-damaged material available in spring

1997, throughout much of northwestern Montana, provided brood sites of which beetles took great advantage. Very high DFB populations began to appear in late summer 1998 near Coeur d'Alene, Idaho, but western Montana didn't show similar increased levels. Because most was either not detected or not salvaged, populations increased markedly in both 1997 and 1998. Aerial detection surveys showed more than 8,300 acres currently infested, with an average 2-3 trees per acre having been killed. Most DF mortality was observed on the Kootenai, Flathead, Lolo and Bitterroot National Forests.

Not related to winter damage, but a similar availability of host material, MPB populations are continuing to build in LPP stands in western Montana which are rapidly growing into more susceptible age classes. An estimated 39,400 acres showed some level of MPB activity. Most was in LPP stands; however, all native pine species have been affected to some extent. Ground surveys showed some LPP stands on the Lolo National Forest are experiencing mortality at a rate of 80-100 trees per acre per year. The largest areas of MPB were in western Montana on the northwestern part of the Lolo National Forest. Other infestations were concentrated on Flathead National Forest.

WBBB-infested areas remained about the same in 1998 with slightly lower intensity on the Gallatin and Beaverhead National Forests; however, populations increased somewhat on Flathead National Forest as well. Other Forests showed varying levels of infested SAF stands. In total, an estimated 59,200 acres were infested in 1998, on which 2-3 trees per acre were killed.

FE populations decreased slightly from 615 acres infested in 1997. Only about 520 acres had some level of damage associated with FE in 1998. As long as moisture levels remain about normal, it is anticipated that infested areas will continue to decline.

Other bark beetle species--IPS, ESB, WPB, and RTB--while observed at varying but noticeable levels from forest to forest--remained at low to endemic levels throughout the Region. Mortality in PP stands, attributed to WPB, increased from 857 acres in 1997 to 1,147 acres in 1998; but was widely scattered in fairly small groups throughout the type.

Table 1, information which was obtained from annual aerial surveys, shows a comparison of infested acres for major bark beetle species for past 5 years. Such comparisons, when accompanied by information from accompanying narratives, enable assessment of population trends. Many beetle-infested areas have been surveyed on the ground; still, most information is based on aerial survey estimates. Our ability to conduct ground surveys is limited by time and personnel, but they are an integral and necessary part of our effort to assess bark beetle population trends and associated impacts.

Infestation summaries, by bark beetle species follow. Bark beetle status is noted by "reporting area"--typically a National Forest and it's surrounding or associated lands of other ownerships: State, other Federal, and private. Included are areas affected, estimate of impacts, and to the extend possible, a prognosis of population trends.

Douglas-fir Beetle (DFB)

As a result of large amounts of wind-thrown and storm-damaged DF, throughout many parts of western Montana, during winter 1996-97, and relatively mild temperatures for the past two winters; DFB populations have increased dramatically over the past two years. We were aware of some blowdown, in more obviously affected stands; however, we now believe there was more "scattered" windthrow which went largely undetected. It was only during the field season of 1998, as we began to find more and more areas with currently infested trees, and as trees attacked early in the season began to fade--the result of hotter and drier-than-normal conditions in late summer--that we began to realize the extent of current outbreaks.

Though not as extensive as in northern Idaho, DFB populations have now reached epidemic proportions in many parts of western Montana. Forested areas most severely impacted are found on Lolo, Flathead and Kootenai National Forests and adjacent State and private lands. Other areas are affected to lesser extents. Beetle populations in DF forests east of the Continental Divide are generally lower; however there are a few areas on Gallatin National

Forest with unusually high amounts of beetle-caused mortality.

On Bitterroot National Forest, many small and scattered groups of beetle-killed trees were found in Daly Creek drainage and near Skalkaho Pass (mostly Darby RD). Numerous 10- to 15-tree groups were mapped south and east of Painted Rocks Reservoir, in Overwich and Hughes Creek drainages (West Fork RD).

The most severe outbreak on Flathead National Forest is on Tally Lake RD--a result of effects of the Little Wolf fire, in 1994. Now, however, there are epidemic populations outside the fire-affected area. In 1998, we used pheromone-baited funnel traps at 18 sites within or near the burn perimeter, in an effort to contain those populations. In 175 traps, we trapped an estimated 860,000 beetles. In addition, about 850 "spill-over" trees were attacked and subsequently removed. Still, there are areas not many miles to the east where beetle-caused mortality is unusually high. On other parts of the Forest, scattered beetle-killed trees were observed on Coram Experimental Forest near Martin City; and in Spotted Bear River drainage (Spotted Bear RD). Neither of those infested areas are as extensive as they were a few years ago. Scattered beetle-caused mortality was noted south of Spotted Bear, extending into Bob Marshall Wilderness. On the adjacent Flathead Indian Reservation, beetle-killed DF were mapped in a light and scattered pattern throughout southern Mission Mountains.

On Gallatin National Forest, lightly scattered mortality was noted in Crazy Mountains (Livingston and Big Timber RDs). Some small infestations remain in Sixmile and Mill Creek drainages, south of Livingston (Livingston RD), but are reduced from previous years. Numerous, but relatively small groups of beetle-killed trees were observed in Boulder River drainage south of Big Timber (Big Timber RD). Heavier concentrations of beetle activity were noted in Bear Creek and associated drainages, near Jardine (Gardiner RD).

In Glacier National Park, many small groups--numbering to 50 trees each--of dead DF were observed throughout stands west of the Continental Divide. Significant concentrations of beetle-killed trees were noted near Logging and Kintla Lakes.

But a remnant of once extensive outbreaks, beetle-infested DF were once again mapped south and west of Lincoln, on Helena National Forest (Lincoln RD). Affected stands were seen along Blackfoot River and east of Nevada-Ogden Road. Beetle-caused mortality there is much reduced from just a few years ago.

On Kootenai National Forest, many small and scattered groups of beetle-killed trees noted north and east of Eureka (Fortine RD). More numerous groups were mapped south of there along Fisher River, in stands adjacent to Highway 2 south of Libby, along western side of Koocanusa Reservoir, and north of Kootenai River west of Libby (Libby RD). More heavily infested stands were noted west of Libby, particularly in lower Yaak River drainage, north of Troy (Three Rivers RD). Other stands on Three Rivers RD, southward towards and surrounding Bull Lake, were affected. On Cabinet RD, many beetle-killed groups of DF were mapped along Bull River, south and east of Bull Lake, along Clark Fork River near Trout Creek, and in association with root disease-affected areas south of the Clark Fork. Many beetle-infested stands have resulted from extensive fires in 1994. While beetle-caused mortality is high in numerous areas, ground surveys suggest in many areas beetle populations should begin to decline in 1999.

On Lolo National Forest, many small groups of beetle-infested stands were mapped south and east of Missoula, mostly south of I-90. They were particularly numerous in and near Rock Creek drainage. A few beetle-killed groups extended into Rattlesnake drainage, northeast of Missoula (Missoula RD). Widely scattered groups of dead DF were mapped along and north of Clark Fork River, becoming more numerous near Thompson Falls. Beetle-killed trees were especially noticeable within Thompson River drainage. Infested groups were less frequently noted in Prospect Creek drainage to the west.

In summary, infestation totals--acres infested and trees killed--were up significantly from 1997, when an estimated 4,000 acres were infested in Montana. In 1998, infested area increased to 8,300 acres, on which 23,700 trees were killed. Typically, an average 2-3 trees per acre per year are killed in most DFB outbreaks which last 2-4 years in a particular area. Ground surveys

conducted in several beetle-infested areas showed that ratio has increased in the past year. Many beetle-infested groups containing 5-10 dead trees last year, had expanded to 20-50 new attacks in 1998. Data showed in some areas, 1998-attacked trees were 4-7 times those infested in 1997. Too, because some trees began to "fade" in late summer, numerous groups were noted on Lolo, Kootenai and Flathead National Forests which contained only 1998-killed trees.

To what extent those infested groups "expand" in 1999, will be determined by weather and availability of susceptible hosts. It is a somewhat general consensus, however, that 1998 appears to have been the "peak" year for these series of outbreaks in most areas. Because of high level of attacked trees in 1998, the general trend of most DF epidemics, and what appears to be above-average precipitation during winter 1998-99; we believe beetle populations will generally decline in 1999. There may be the "appearance" of an increase because most trees killed in 1998 have not yet faded. "Faded" trees in 1999 will, indeed, be more numerous than in 1998. It is likely, however, that in most areas attacked trees will be fewer in 1999. Still, tree killing may continue at a declining rate, for the next year or so. Should winter conditions create additional brood sites in the form of blowdown or breakage, or we have an unusually warm and dry spring in 1999, that prognosis could change.

Spruce Beetle (ESB)

Spruce beetle populations remained at virtually endemic levels throughout Montana in 1998. In 1997, only about 1,500 acres had been infested. That figure increased slightly to 2,000 acres in 1998. Small amounts of widely scattered beetle-killed ES were observed on the Flathead National Forest (Tally Lake and Glacier View RDs) and in several drainages within Glacier NP. The few faded trees noted on Tally Lake RD were some distance from the area of Little Wolf burn, and appeared unrelated to the successful suppression project conducted there in 1996 and 1997.

Fir Engraver (FE)

Fir engraver populations, and associated mortality in GF stands declined slightly in 1998 from 1997. Some minor amounts of FE-killed trees were observed in Prospect Creek drainage (Plains/Thompson Falls RD, Lolo NF). Only slightly more than 500 of those infested acres were recorded in Montana in 1998.

Pine Engraver (IPS)

No significant pine engraver outbreaks were noted anywhere in Montana in 1998. A few beetle-killed trees were observed in PP stands on several forests, but they were almost always in conjunction with WPB or MPB infested stands. A small group of PP was determined to have been killed by IPS east of Georgetown Lake (Deerlodge National Forest), and some low-elevation PP stands were affected to a minor extent in western Montana. Areas in eastern Montana, where IPS outbreaks are more prevalent were not aerial surveyed in 1998. Trips to those areas, however, revealed nothing more than endemic levels of IPS-related tree mortality. Throughout Montana, just under 700 acres showed some level of IPS-caused mortality.

A successful trapping program was conducted on Libby RD (Kootenai National Forest) where slash piles created in late winter/early spring were heavily infested by engraver beetles. About 130 pheromone traps, placed around 43 infested piles captured an estimated 54,000 emerging IPS throughout the flight season. We have thus far found no trees in the vicinity of slash piles which were attacked. Slash piles were burned in early autumn.

Mountain Pine Beetle (MPB)

Across Montana, MPB has once again become the most expansive and damaging bark beetle pest--impacting all native and introduced pine species throughout its range, but primarily in western Montana.

The most intense and damaging MPB outbreaks in Montana are found on Lolo National Forest, located in LPP stands regenerated after fires early in this century on Ninemile, Superior, and Plains/Thompson Falls RDs. Eastern most extension of those outbreaks were located in Mill Creek drainage, north of Frenchtown. Proceeding northwestward from there, outbreaks become more noticeable in upper Ninemile Valley, where several large groups of faded LPP were mapped near Seigel Pass. From there, along CC Divide and in upper

portions of Sloway Gulch, Tamarack Creek, and towards Twelvemile Creek, huge groups of beetle-killed LPP were observed. A few in Sloway Gulch area numbered 10,000 trees each; others near Tamarack Creek and Camels Hump contained 20,000 trees each. Some of those more intensive outbreaks extend into LPP stands on Plains/Thompson Falls RD, as well. Stands in Coeur d'Alene Mountains, around Patrick Knob have been especially heavily infested. In total, on Lolo National Forest, in just LPP type, more than 22,800 acres were infested in 1998 and about 184,000 faded trees were mapped--an average of more than 8 trees per acre killed in a single year.

MPB outbreaks also appear to be building in aging LPP stands on Spotted Bear RD, Flathead National Forest. Most of the nearly 1,600 infested acres found on the Forest were mapped near Spotted Bear Lake and in upper portions of South Fork Flathead River. Scattered, smaller groups of beetle-killed LPP were also located in vicinity of Crane Mountain and north of Lake Mary Ronan on Swan Lake RD. Elsewhere on the Forest, small and widely scattered beetle-infested groups of LPP were found on Hungry Horse RD in association with MPB-infested WWP stands on both east and west side of Hungry Horse Reservoir. About 1,100 acres of infested LPP were found on adjacent Flathead Indian Reservation. Most were found in vicinity of Hot Springs, around Rainbow Lake, and on southeastern portion of the Reservation in Jocko River drainage and its tributaries.

Other host species affected by MPB in 1998--PP, WWP and WBP/LP--were widely scattered throughout the various types, wherever found in the State. No major concentrations were found in anyone location; however, scattered PP mortality totaled almost 8,000 acres in Montana. Significant, but small outbreaks were recorded on the Bitterroot National Forest in low-elevation PP stand in foothills of Sapphire and Bitterroot Mountains. Particularly noticeable were stands in French Basin (Sula RD) and on Threemile State Wildlife Management Unit northeast of Stevensville. Widely scattered groups of beetle-killed PP were also noted throughout northern portion of Flathead Indian Reservation. Groups of beetle-killed PP large enough to be of concern were observed on Lewis and Clark National Forest, in Castle Mountains; and on both Rocky Boys and Ft. Belknap Indian Reservations.

Western Balsam Bark Beetle (WBBB)

The most expansive outbreaks in the Region remained on Gallatin and Beaverhead National Forests. Many large groups of faded SAF were mapped on Hebgen Lake and Bozeman RDs in Madison and Gallatin Ranges on both east and west sides of Gallatin Canyon. Stands at higher elevations were infested from Hebgen Lake and Yellowstone National Park, north to Spanish Peaks and Hyalite Reservoir. On Gardiner RD, numerous large groups of beetle-killed trees were observed near Cooke City; and on Big Timber RD, faders were noted in West Fork Boulder River from War Eagle Mountain to Sheep Herder Peak. On other parts of the Forest, fader groups were more scattered.

Next most heavily infested Forest was the Beaverhead, where more 18,600 acres were infested to some extent. On Dillon RD, numerous large groups of beetle-killed SAF were found north of Lima Reservoir and Red Rock Lakes, and north throughout Gravelly Range, nearly to Virginia City. On Wise River RD, WBBB-caused mortality was noted widely scattered throughout Pioneer Mountains. On Wisdom RD, faded trees were mapped west of Wisdom, from Anaconda Range on the north to Beaverhead Mountains on the south.

Western Pine Beetle (WPB)

Few areas in western Montana were seriously affected by WPB populations in 1998. A small number of PP stands along Clark Fork and Bitterroot Rivers (Lolo and Bitterroot National Forests reporting areas, respectively), and on Flathead Indian Reservation, were observed which had minor amounts of beetle-killed trees. No major WPB outbreaks were known to exist in western Montana, and WPB has never been found east of the Continental Divide in Montana. In total, just over 1,100 acres were mapped with small amounts of WPB-killed PP. Less than 900 trees were estimated to have been killed. Above average precipitation received in late fall 1998, and predicted for winter 1999, would suggest WPB populations will likely decline in 1999.

Table 2. Douglas-fir beetle-infested acres in Montana, all ownerships, from 1995 through 1998

	1995			1996			1997			1998		
Reporting Area	Acres	Trees	Vol. (MBF)[1]	Acres	Trees	Vol. (MBF)	Acres	Trees	Vol. (MBF)	Acres	Trees	Vol. (MBF)
Beaverhead NF	6	8	1.6	31	60	12.0	104	118	23.6	95	146	29.2
Bitterroot NF	64	121	36.3	145	121	36.3	102	292	87.6	358	800	240.0
Custer NF	102	256	51.2	663	456	91.2	60	162	32.4	27	60	12.0
Deerlodge NF	19	21	4.2	40	69	13.8	51	148	29.6	319	523	104.6
Flathead NF	757	1,840	552.0	535	1,353	405.9	531	1,264	379.2	796	2,093	627.9
Gallatin NF	224	502	100.4	737	1,612	322.4	212	602	120.4	750	1782	356.4
Helena NF	1,421	1,082	216.4	322	636	127.2	269	649	129.8	241	530	106.0
Kootenai NF	554	1,434	430.2	321	797	239.1	390	765	229.5	2,284	8,475	2,542.5
Lewis & Clark NF	94	35	7.0	29	222	44.4	213	310	62.0	190	276	55.2
Lolo NF	445	622	186.6	922	1,819	545.7	1,066	1,942	582.6	2,332	6,305	1,891.5
Garnets	79	116	34.8	125	325	65.0	86	141	28.2	257	674	134.8
Flathead IR	95	156	46.8	197	118	35.4	183	317	95.1	152	265	79.5
Crow IR	8	10	2.0	9	11	2.2	4	5	1.0	★	★	★
Glacier NP	1,371	1,877	563.1	64	203	60.9	136	362	108.6	492	1,726	517.8
Yellowstone NP	549	880	176.1	★[2]	★	★	537	1,577	315.4	★	★	★
Other	0	0		13	11	2.2	10	9	1.8	16	36	7.2
TOTAL	5,798	8960	2,408.7	4,353	7,813	2,003.7	3,995	8,663	2,226.8	8,310	23,688	6,704.6

[1]MBF = 1,000 board ft

[2]★Not flown

Table 3. Acres of mountain pine beetle-caused mortality on state and private lands in Montana from 1995 through 1998

	1995				1996				1997				1998			
Reporting Area	LPP[1]	PP	WBP	WWP	LPP	PP	WBP	WWP	LPP	PP	WBP	WWP	LPP	PP	WBP	WWP
Beaverhead NF	15	2	0	0	2	0	0	0	4		0	0	38	2	4	0
Bitterroot NF	14	428	0	0	0	291	0	0	0	1,827	0	0	4	824	0	0
Custer NF	2	42	0	0	4	4	0	0	6	77	0	0	4	---	0	0
Deerlodge NF	25	21	0	0	25	66	0	0	26	12	0	0	120	115	0	0
Flathead NF	278	463	2	340	104	10	0	139	46	97	0	158	142	41	2	944
Gallatin NF	2	0	17	0	119	13	0	0	517	34	10	0	178	4	10	0
Helena NF	143	290	15	0	39	179	6	0	73	312	12	0	21	225	8	0
Kootenai NF	416	109	0	60	90	34	0	34	72	16	2	51	56	31	0	33
Lewis & Clark NF	11	389	0	0	89	953	7	0	147	3,047	0	0	68	384	0	0
Lolo NF	1,931	1,114	7	0	1,302	922	0	14	2,008	1,126	13	19	2,040	1,101	0	0
Garnets	17	374	0	0	12	2,029	0	0	22	629	0	0	22	314	0	0
Crow IR	★[2]	★	★	★	0	48	0	0	0	4	0	0	NF	NF	★	★
Fort Belknap IR	★	★	★	★	0	17	0	0	0	169	0	0	3	338	0	0
No. Cheyenne IR	★	★	★	★	0	0	2	0	0	4	0	0	NF	NF	★	★
Rocky Boy IR	★	★	★	★	0	60	29	0	142	22	0	0	198	20	0	0
Flathead IR	★	★	★	★	0	466	0	0	29	124	0	0	53	146	0	0
Other	42	338	0	0	0	0	0	0	0	0	0	2	0	0	0	0
Total	2,896	3,570	41	400	1,786	5,092	44	187	3,092	7,500	37	228	2,946	3,544	24	977

[1]LPP = Lodgepole pine; PP = ponderosa pine; WBP = whitebark pine; WWP = western white pine

[2]★Not flown

Table 4. Acres of mountain pine beetle-caused mortality on Federal ownership in Montana from 1995 through 1998

	1995				1996				1997				1988			
Reporting Area	LPP[1]	PP	WBP	WWP	LPP	PP	WBP	WWP	LPP	PP	WBP	WWP	LPP	PP	WBP	WWP
Beaverhead NF	65	2	21	0	46	0	12	0	125	4	10	0	486	4	31	0
Bitterroot NF	37	366	0	0	48	340	0	0	18	463	0	0	63	358	2	0
Custer NF	0	266	0	0	1	0	6	0	60	447	9	0	0	0	0	0
Deerlodge NF	109	4	0	0	137	82	8	0	86	14	6	0	350	66	4	-0
Flathead NF	1,729	78	21	479	965	6	31	224	793	24	26	213	1,461	8	32	242
Gallatin NF	20	0	118	0	134	0	99	0	304	24	85	0	119	0	314	0
Helena NF	508	221	58	0	126	216	25	0	144	160	54	0	78	307	30	0
Kootenai NF	2,941	121	8	1,002	372	53	2	378	663	42	4	429	1087	74	4	506
Lewis & Clark NF	120	488	7	0	558	585	11	0	443	1,047	6	0	259	526	4	0
Lolo NF	11,465	1,836	27	152	11,629	1,487	7	178	12,766	1,525	34	219	20,087	1,139	8	88
Crow IR	0	8	0	0	2	101	0	0	6	8	0	0	★	★	★	★
Fort Belknap IR	★[2]	★	★	★	86	1,045	0	0	107	1,129	0	0	98	1,861	0	0
Flathead IR	582	593	0	0	507	323	0	0	693	306	0	0	1,011	144	0	0
No. Cheyenne IR	0	210	0	0	0	0	0	0		587	0	0	★	★	★	★
Rocky Boy IR	20	8	0	0	58	46	0	0	60	60	0	0	132	88	0	0
BLM (Garnets)	0	44	0	0	32	28	0	0	6	47	2	0	8	27	0	0
Glacier NP	55	2	2	537	24	0	0	60	14	0	0	16	6	0	0	47
Yellowstone NP	15	0	0	23	★	★	★	★	20	0	22	0	★	★	★	★
Total	18,268	5,066	262	2,193	15,678	5,827	201	840	16,308	5,887	258	877	25,964	4,601	430	882

[1]LPP = Lodgepole pine; PP = ponderosa pine; WBP = whitebark pine; WWP = western white pine

[2] ★ = Not flown

Table 5. Bark beetle infested acres (other than mountain pine beetle and Douglas-fir beetle) in Montana.

	Englemann Spruce Beetle				Pine Engraver Beetle				Western Pine Beetle				Fir Engraver Beetle				Western Balsam Bark Beetle			
Reporting Area	1995	1996	1997	1998	1995	1996	1997	1998	1995	1996	1997	1998	1995	1996	1997	1998	1995	1996	1997	1998
Beaverhead NF	0	2	14	0	0	0	156	382	0	0	118	0	0	0	0	0	18,381	18,359	6,081[1]	18,612
Bitterroot NF	2	6	6	16	156	0	0	2	212	199	0	172	14	0	0	4	42	30	12	59
Custer NF	0	324	0	0	49	0	33	0	0	0	0	0	0	0	0	0	166	472	434	37
Deerlodge NF	11	0	3	2	14	0	0	134	17	25	8	28	0	0	0	4	32	93	61	99
Flathead NF	76	278	537	878	36	0	2	0	94	73	38	72	61	123	92	111	415	826	765	760
Gallatin NF	204	396	299	2	112	0	60	0	0	0	0	0	0	0	0	0	20,888	24,233	21,251	38,806
Helena NF	22	14	8	4	35	0	0	2	0	0	106	0	0	0	0	0	844	143	111	65
Kootenai NF	0	4	115	59	34	0	0	4	181	128	91	224	65	29	289	120	297	50	123	287
Lewis & Clark NF	11	8	2	2	637	0	32	36	0	0	0	0	192	0	0	0	235	282	430	241
Lolo NF	11	129	38	34	2,896	0	157	22	2,018	529	314	432	0	215	215	253	207	133	161	168
Garnets	0	0	0	2	549	0	0	3	137	0	45	58	17	0	0	0	8	4	12	2
Flathead IR	0	2	2	4	1,983	0	6	113	102	159	136	161	0	31	18	26	34	16	13	99
No. Cheyenne IR	4	0	0	*	231	0	65	*	0	0	0	*	0	0	0	*	*	0	0	*
Fort Belknap IR	*[2]	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0
Rocky Boy IR	*	0	0	0	*	2	0	0	*	0	0	0	*	0	0	0	*	0	0	0
Crow IR	*	0	0	*	*	10	0	*	*	0	0	*	*	0	0	*	*	35	0	*
Glacier NP	*	103	342	991	*	0	0	0	*	2	2	0	*	2	2	0	*	6	0	14
Yellowstone NP	*	*	136	*	*	0	0	*	*	*	0	*	*	0	0	*	*	*	634	*
Total	249	1,266	1,502	1,995	6,732	12	513	698	743	1,115	857	1,147	349	400	615	519	41,549	41,549	30,088	59,248

[1] = Only a portion of the Beaverhead NF was flown in 1997

[2] * = Not flown

Figure 2.

Areas of Douglas-fir beetle infestations in Montana, 1998.

Figure 3.

Areas of mountain pine beetle infestations in Montana (all host species) 1998.

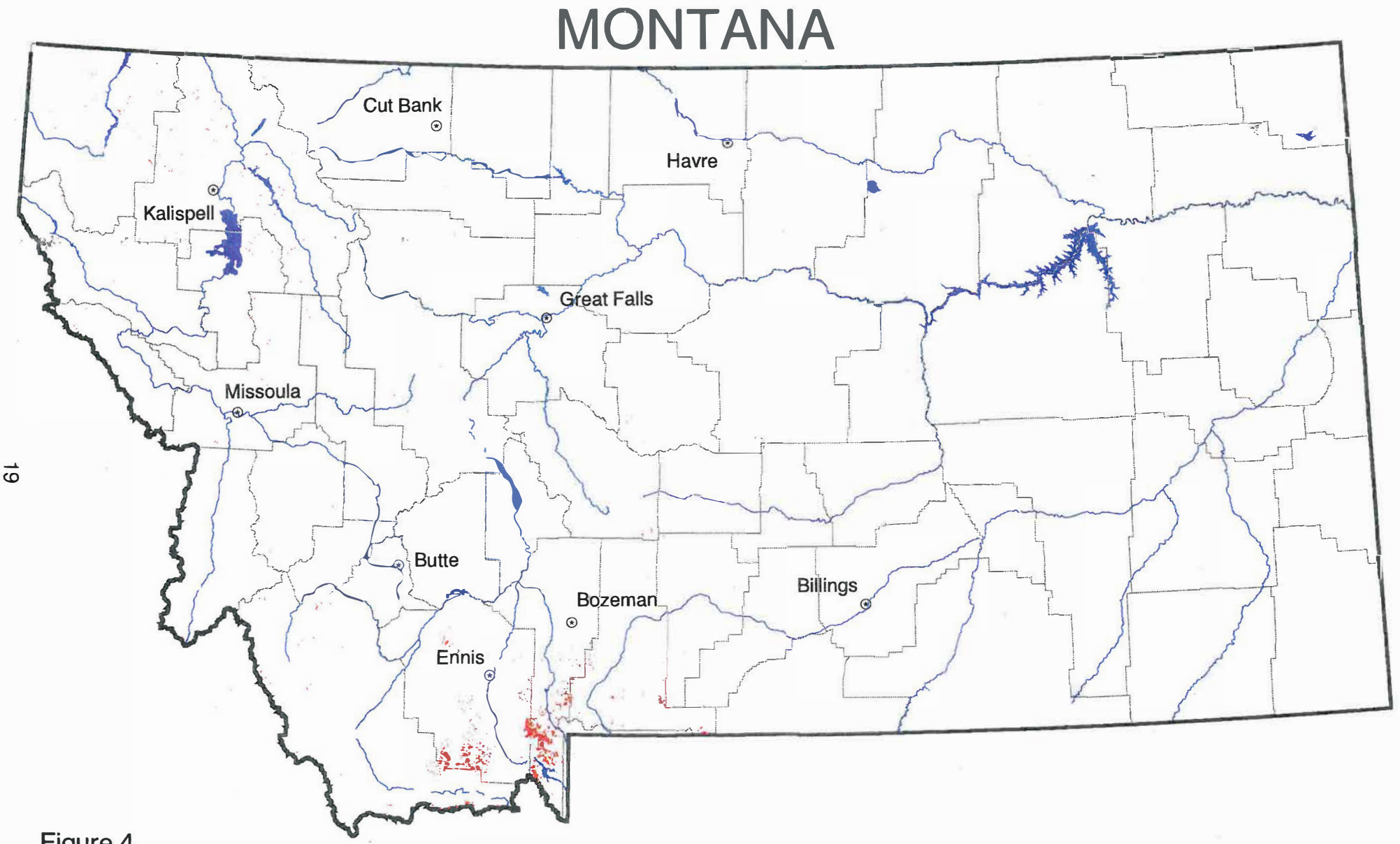


Figure 4.

Areas of subalpine fir mortality caused by western balsam bark beetle and other agents in Montana, 1998.

Caterpillars were also observed on cottonwoods in Washoe Park in Anaconda, but no defoliation was observed. Defoliated trees in many of the areas were checked again in late summer to observe extent of recovery. All trees checked had completely refoliated.

Other Defoliators

Several other defoliators were found in Montana's riparian areas in 1998. Tent caterpillar defoliation was observed in cottonwoods along Interstate 90 west of St. Regis for several miles and just above the mouth of Rock Creek east of Missoula. Heavy feeding by willow leaf beetle was reported from Thompson Falls and sites in eastern Montana. Later in the summer, defoliation by fall webworm was observed in many locations throughout the state.

DISEASES

General Summary

Most Important Diseases

Annosus Root Disease	Ponderosa Pine Douglas-fir Subalpine fir Other Conifers	Common in ponderosa pine stands west of the Continental Divide; especially severe on the Flathead Indian Reservation.
Armillaria Root Disease	Douglas-fir Grand Fir Other Conifers	Widely distributed, especially west of the Continental Divide. This is the most damaging root disease in western Montana. Infected trees are often attacked by bark beetles.
Laminated Root Rot	Douglas-fir Grand Fir Other Conifers	Occurs throughout the range of Grand fir in northwestern Montana and is known to be particularly damaging on the Lolo and Kootenai National Forests. Infected Douglas-fir and grand fir are often attacked by bark beetles.
Dwarf Mistletoe	Lodgepole Pine Douglas-fir Western Larch	Dwarf mistletoes are widespread throughout the state and one of the leading causes of forest growth loss. Dwarf mistletoe-caused growth losses are estimated at about 33 MM ft^3/year. Lodgepole pine mistletoe occurs throughout the range of lodgepole pine. Douglas-fir mistletoe is scattered throughout the range of Douglas-fir west of a north-south line roughly 25 miles east of Missoula. Western larch dwarf mistletoe occurs throughout the range of western larch in western Montana.
White Pine Blister Rust	Western White Pine Whitebark Pine	Precludes the management of wild western white pine on all but low hazard sites throughout the range of western white pine. Rust resistant white pine has been successfully established on the Lolo, Kootenai, and Flathead National Forests. White pine blister rust occurs throughout the range of whitebark pine causing severe mortality in localized areas and a reduction in cone production.
Pini Rot	Western Larch Pines Douglas-fir True Firs Spruce	Serious decay problem in mature conifers. May also occur at high levels in younger trees. Most important hosts are western larch and ponderosa pine.

Diseases of Local Importance

Stem And Branch Diseases

Aspen Canker and Trunk Rot	Aspen	Common in most aspen stands in Montana particularly east of the Continental Divide.
Atropellis Canker	Lodgepole Pine	Found in pockets in pole-sized stands causing defect and some mortality. Localized heavy infections are known to occur in western Montana.
Comandra Rust	Lodgepole Pine Ponderosa Pine	Causes growth loss, deformity, top kill and mortality. Especially severe in lodgepole pine in south-central Montana.
Cytospora Canker	Subalpine Fir Douglas-fir Grand Fir	Occurs throughout the range of hosts. Causes branch flagging in large trees and dead tops and mortality in seedlings and saplings. Large trees may be predisposed to bark beetle attack or killed directly following drought stress.
Diplodia Blight	Ponderosa Pine	Causes stunting and mortality of new shoots. Serious infections may lead to death of the tree in association with bark beetle attack. Diplodia is scattered throughout Montana and is locally severe at several locations.
Indian Paint Fungus	Grand Fir Western Hemlock	Occurs throughout the range of hosts. This fungus is the major cause of defect in mature true fir and hemlock in western Montana.
Stalactiform Rust	Lodgepole Pine	Causes growth loss and occasional mortality. Found throughout the range of lodgepole pine and is severe in localized areas.
Western Gall Rust	Lodgepole Pine Ponderosa Pine	Causes stem and branch galls and mortality in small trees. Occurs throughout range of hosts. Infection levels are highly variable.

Root Diseases

Black Stain	Douglas-fir Lodgepole Pine Ponderosa Pine	Has been confirmed in relatively few locations in the state, all of which are west of the Continental Divide.
Brown Cubical Root and Butt Rot	Douglas-fir Other conifers	Occurs throughout the range of hosts. Causes extensive root and butt rot; especially damaging in stands more than 80 years old.

Foliage Diseases

Elytroderma Needle Disease	Ponderosa Pine	Fungus infects the needles, twigs, and branches and causes brooming. Severe, chronic infections can cause deformation and occasional death of small trees. Known to be locally severe in the Bitterroot Valley and around Flathead Lake.
Larch Needle Blight and Needle Cast	Western Larch	Occurs throughout the range of western larch. Severe infections in successive years may cause growth loss in large trees and mortality in seedlings.
Rhabdocline Needle Cast and Swiss Needle Cast'	Douglas-fir	Occur throughout the range of Douglas-fir and are quite common in northwestern Montana. Infected needles are killed and shed. Important in young plantations including tree improvement areas and Christmas tree operations.

Specific Disease Reports

Root Diseases

Annosum Root Disease in Ponderosa Pine

Much discussion has also gone on regarding annosum root disease in ponderosa pine. The presence of annosum root disease has significant implications regarding management of ponderosa pine, especially old growth ponderosa pine. FHP personnel have been making the recommendation to treat ponderosa pine stumps in areas at high risk from annosum root disease. The recommendation is to treat stumps 13" or greater with a borate compound at the time of harvesting. Although a draft of management recommendations has been written, it has not been released as a document. We thought it prudent to develop a survey for determining the incidence of annosum root disease in ponderosa pine in Region 1, as well as narrowing down the definition of "high risk" areas before releasing a document of management recommendations. A preliminary survey was initiated on the Bitterroot NF during the summer of 1998 and we plan to do more ground work during 1999. Please contact the Missoula Field Office for more information regarding stump treatment recommendations.

Tomentosus Root Disease

This root disease keeps "popping up" in our service visits. It has sparked interest around the region and we discussed it in the 1996 Montana Forest Insect and Disease Conditions and Program Highlights. Tomentosus root disease is relatively common in the Region; we usually find it acting as a root and butt decay in lodgepole pine, subalpine fir and Douglas-fir. We recently found it acting as a locally significant root disease in western larch on the Bitterroot NF. In this situation, the western larch was infected with dwarf mistletoe and growing in the vicinity of root diseased Douglas-fir. The larch were showing crown symptoms indicative of root disease, and the roots were very resinous and had advanced decay from tomentosus root disease. The dwarf mistletoe and the lateral competition from surrounding trees likely predisposed the larch to the root disease.

Foliage Diseases

Elytroderma Needle Blight

Localized areas of heavy infection from Elytroderma were seen in 1998. Elytroderma has been heavy in several areas for a number of years, including the Jette Lake area north of Polson, but in 1998, a number of "new hot" areas were reported. It was especially heavy in the south Bitterroot Valley and the Rock Creek drainage east of Missoula, causing much concern from the private landowners in both areas. This increase in Elytroderma indicates that favorable weather conditions for infection

must have occurred during late spring and early summer of 1997. The wet weather we experienced in June and early July of 1998 makes it probable that we will see more Elytroderma in 1999.

Elytroderma needle blight is most damaging in trees of low vigor with poor crowns; however, the disease is often more conspicuous in good crowns. It is assumed moderately and severely infected trees experience some level of growth loss, but these effects have not been quantified in our area. Damage from Elytroderma needle blight can be minimized by maintaining vigorous tree growth and removing several infected mature trees, the disease may become more pronounced after thinning. Trees with poor crowns at the time of infection will incur more damage from the disease than those trees with healthy, vigorous crowns at the time of infection.

Dothistroma Needle Blight

Dothistroma needle blight, caused by the fungus *Dothistroma septospora* (Dorog.) Morelet, appears to be associated with mortality of limber pine in eastern Montana. Nine monitoring transects have been established at several Montana locations. Mortality has been monitored on four transects on the Lewis and Clark National Forest since 1996 and ranged from 12-45 percent, with 85 percent of the mortality attributed to *D. septospora*. The remaining five transects were established in 1998, and mortality data are not yet available. However, on the newly established transects, trees were rated for percent crown affected by *D. septospora*; 72 percent of the trees were rated as having 75 percent or greater of their crown affected. Monitoring of existing transects for defoliation and mortality associated with *D. septospora* will continue into the future, and additional surveying and monitoring may be undertaken if the current outbreak continues or if new areas of infection are discovered.

Lodgepole Pine Needle Cast

Generally speaking, lodgepole pine needle cast (*Lophodermella concolor* (Dearn.) Darker) was reported at lower-than-average- levels in 1998 throughout the state. An exception to this trend was the Homestake Pass area near Butte where the infection level was exceptionally severe. Trees were bright red in June and early July, but by August, the red needles had been shed and the trees looked green and healthy again. The severe level of needle cast seen at Homestake Pass this year indicates that weather conditions conducive for spore release and infection were extremely favorable in that area in June 1997.

Brown Spot Needle Blight

Brown spot needle blight was positively identified on ponderosa pine needles collected in the Yogo Creek area on the Judith Ranger District and the King's Hill area on the King's Hill Ranger District on the Lewis and Clark National Forest. The conidial sate of the causal fungus, *Lecanosticta acicola*, was found on several different needles collected at both locations, and was identified through microscopic examination. This is believed to be the first positive identification of this disease in Montana. The fungus causes yellow to straw-colored spots or bands on needles. Needle tips often turn brown while the needle bases remain green. Tiny, round, black fruiting bodies can be seen in the brown needle tissue in mid to late summer. The fungus continues to develop in infected needles, and the needles are prematurely shed. Little to nothing is known at this time about this pathogen and disease in Montana: What is the fungus life cycle? What hosts are effected? What are the effects on the host? What is the disease distribution and severity? Forest Health Protection may undertake studies in the future in an attempt to answer these questions. In the meantime, people who notice suspicious ponderosa pine in the state are encourage to contact Jane Taylor at the Missoula Field Office.

Other Diseases

Cottonwood Defoliation

1998 was an especially severe year for defoliation of black cottonwood in western and central Montana. The defoliation was caused by the cottonwood leaf rust fungus *Melampsora occidentalis* Jacks. Severe damage was observed along riparian corridors on the Kootenai, Lolo, Flathead, Bitterroot, Lewis and Clark, Helena, Beaverhead-Deerlodge, and Gallatin National Forests. In mid-summer, the trees turned prematurely yellow, largely due to the prolific sporulation of the fungus on the foliage. By late summer the trees turned a dull brown and premature defoliation was common. The severe damage in 1998 was likely the result of extremely wet weather in May and June

which provided an ideal environment for fungus sporulation and initial infection. Although defoliation was quite severe in some areas, tree mortality is not expected to occur.

Aspen Defoliation

Aspen stands in some locations on the Lewis and Clark, Beaverhead-Deerlodge, and Gallatin National Forests were severely defoliated in 1998 by black leaf spot, caused by the fungus *Marssonina populi* (Lib.) Magn. Black leaf spot is the most common foliar disease of aspen throughout the west, and it is found to some degree every year in Montana. 1998 was an especially severe infection year because of the extreme wet weather that occurred in May and June. The disease causes entire clones of aspen to look dull and bronzed. Premature defoliation often occurs, and as a result, the stands do not exhibit their normally striking autumn color display. There is an obvious difference in disease susceptibility between aspen clones, and even in epidemic years, some clones will remain virtually free of the disease. As with most foliar diseases of deciduous trees, even the "epidemics" rarely kill mature trees. Severe defoliation may cause mortality of young sprouts.

Branch Dieback of Whitebark Pine in the Crazy Mountains.

Localized areas of whitebark pine branch dieback were observed on the Gallatin National Forest. The most significant damage was seen on west side of the Crazy Mountains in the upper Smeller Creek and Cottonwood Creek drainages. The damage was significant enough to be detected from the air during the annual detection survey. Attempts were made to visit the areas where the damage was the most severe, but access was limited due to rough terrain and high water. Samples that were taken failed to reveal any biological cause of the damage. White pine blister rust was found to varying degrees at all locations, but this particular branch dieback problem was not the result of rust infection. The pattern of the damage suggests an abiotic, probably weather-related, cause. Additional surveys of the damage areas may be attempted in 1999.

Nursery Diseases

Although seedling production in Forest Service nurseries has declined steadily during the past few years, production at the numerous private and corporate nurseries as well as the Montana State Nursery have remained level or increased slightly. The major diseases of bareroot and container-grown seedlings in forest nurseries in Montana are root and damping-off diseases caused by *Fusarium* spp., foliage blight caused by *Botrytis cinerea*, and periodic abiotic disturbances that may predispose seedlings to weak pathogens. *Cylindrocarpon* root rot remains important on container-grown 5-needle pine species (western white, limber, and whitebark pines). Other pathogens that recur at selected nurseries include *Sirococcus strobilinus, Sphaeropsis sapinea, Pythium* spp., *Meria laricis,* and occasionally *Phytophthora* spp.

Efforts to develop alternatives to chemical control of diseases in nurseries are continuing. Progress has been made in formulating alternatives to soil fumigation, especially with methyl bromide. Alternative fumigants (dazomet, chloropicrin, vapam) have shown efficacy in some situations. Likewise, steam treatment of soil prior to planting shows promise. Fallowing fields for one to several years prior to sowing in some cases may reduce populations of soil-borne pathogens sufficiently that little disease occurs. Application of organic amendments (either as direct amendments or tillage of green manure crops) generally aggravate root disease problems by providing high levels of organic matter which stimulate potential soil-borne pathogens. Biological control agents (BioTrek = formulations of *Trichoderma harzianum;* and others including bacteria) are currently being tested in bareroot nurseries. Biological control agents will likely become more important in the future, particularly when implemented with other measures of an integrated pest management program.

SPECIAL PROJECTS

Insects

Douglas-Fir Beetle Project--Flathead NF

In an ongoing effort to deal with effects of the Little Wolf Fire, of 1994; Tally Lake RD, Flathead NF conducted an integrated

management approach to reduce Douglas-fir beetle-caused mortality in Douglas-fir stands within and adjacent to the fire area. Following the fire, many fire-weakened stands of both Engelmann spruce and Douglas-fir were infested by spruce beetles (*Dendroctonus rufipennis* [Kirby]) and Douglas-fir beetles (*D. pseudotsugae* Hopkins), respectively. Because, initially, spruce beetles presented the greater threat to uninfested stands; that infestation was treated through a combination of sanitation, salvage, trap trees, and funnel traps in 1995-97. Building more slowly, Douglas-fir beetle populations were found to be epidemic in stands not affected by the fire, in 1997. In 1998, 175 pheromone-baited funnel traps were hung, mostly in groups of 9 traps each, in 20 locations throughout fire-affected or adjacent stands.

Traps were hung the week of April 27, baited with two different combinations of pheromone lures, and removed between August 24 and September 1. Pheromone lures were the commercially available frontalin, ethanol and MCOL; and as a comparison, an "experimental" combination of frontalin, ethanol and seudenol. Beetles were apparently flying at the time traps were hung--we found beetles in traps on April 28. Peak beetle flight occurred between July 7-15--more than a month later than a "typical" Douglas-fir beetle flight, which usually is completed in early June. By the end of August we were collecting almost no beetles, though a few beetles may have flown after September 1. In total, we collected an estimated 860,000 beetles. In addition, about 825 Douglas-fir were attacked in stands within 200-300 feet of trap clusters. Those infested trees were removed in fall, 1998. Between trap catches--perhaps the equivalent of 1,000 attacked trees--and attacked trees removed, we believe we have reduced beetle population, in that area, to nearly endemic levels. There are, however, beetle populations elsewhere on the RD, a reflection of higher-than-normal populations throughout much of western Montana and northern Idaho (as noted in this report). Additional surveys, salvage, and a smaller trapping effort will be conducted in 1999.

In addition to the trapping effort, there were three areas in which stand conditions precluded the use of traps or additional salvage. Because of their old-growth character, and the desire to protect their present structure, we treated those three areas with DFB anti-aggregant, methylcyclohexanone (MCH). Research completed within the past several years has shown MCH to be very effective in protecting standing, green Douglas-fir from attack by DFB. MCH is formulated and applied as a liquid, encapsulated in a polymer "bubble capsule," and manufactured to elute through beetle flight period. Recommended rate of application is 30 bubble capsules per acre, with capsules being stapled to trees or other vegetation on about a 40-feet by 40-feet grid. In the largest area, approximately 15 acres, we placed 408 bubble capsules. In the other two we placed 142 capsules and 50 capsules, about 5 and 2 acres, respectively. Bubble capsules were installed during the first week of May--which was a few days after beetle flight began. Still, evaluations following beetle flight showed no new attacks in any of the three treated areas.

Engraver Beetle Project--Kootenai NF

Libby RD, Kootenai NF personnel conducted an engraver beetle (Ips pini [Say]) population reduction project in a thinned stand north of Libby, in 1998. During late winter and early spring, a predominantly ponderosa pine stand had been thinned to improve stand vigor, reduce threats from mountain pine beetles, and reduce threats of wildfire in the urban/forest interface. Slash was piled in piles throughout the treated area of several hundred acres. Approximately 1/3 of the densely stocked and 80-year-old stand was removed. Slash piles ranged in size from 15-100 feet in diameter and 8-15 feet in height. All were heavily infested by beetles emerging from overwintering sites, in early to late April. While some piles were likely large enough to contain beetles throughout the flight season; pheromone-baited funnel traps were hung around each pile to attract emerging beetles and help assure no leave trees were killed in mid-summer. Traps, varying from 3 to 4 around each pile, were hung in early May--after initial flights were over, but before brood development was completed. Traps were standard 8-funnel, Lindgren trap, baited with the commercially available I. pini lure--lanierone and ipsdienol. Traps were hung on tripods constructed from iron, concrete reinforcing rods, cut to lengths of about 10 feet.

Traps were collected weekly, from May 25 to August 4 when trap catches had declined markedly. Traps were removed and slash piles were subsequently burned. Around 43 slash piles, we hung 128 traps. First beetles were collected May 25, peak flight occurred about July 7, and last beetles were collected on August 4 (though flights may not have been entirely over). In total, an estimated 54,000 beetles were collected--an average of more than 400 per trap. We believe the trapping effort was successful in that we found no attacked trees during fall evaluation. It is possible that some tops were killed and will begin to fade in spring 1999. But we have no indications, thus far, that tops or whole trees were attacked anywhere in the trapping area.

Developing techniques to monitor insects as agents for biological control of spotted knapweed, evaluating impact and determining optimum site release strategies

Beginning in 1997, a study was conducted to evaluate the effects of several "key" biological control agents on spotted knapweed. The objectives were to: (1) develop monitoring techniques to detect the establishment and spread of two root feeding biological control agents, *Agapeta zoegana* and *Cyphocleonus achates* for spotted knapweed reduction in forested areas, (2) evaluate the impact of these two agents on knapweed populations, and (3) develop a risk-rating system to determine the optimum forest sites for releases of agents, based upon the site and stand characteristics for five of the most promising root and seed head infesting insects. Cooperators on this project included forest and district land managers, County Extension agents and County Weed supervisors, and the University of Montana and Massachusetts and Montana State University.

During the 1997 field season, we sampled 67 sites to develop the monitoring tools and the risk-rating system. At each site, 52 roots were collected and examined for larvae of both species. Adults were also surveyed at each site using a visual estimate technique. We also evaluated the impact of the root feeding insects on knapweed populations at 13 sites. At these sites, we will have both pre- and post-release vegetation density measurements and insect population measurements. All of these sites are on the Lolo NF and Andy Kulla, Resource Forester, provided the pre-release vegetation measurements.

During 1998, we sampled an additional 58 sites in both Montana and Idaho to further develop the monitoring tools and the risk-rating system. Many of the new sites were county releases. As many as 169 *Agapeta* larvae and 13 adults were found at one site. We also evaluated several new monitoring techniques for the two root feeding insects including pheromone trapping for *Agapeta* and sweep netting for the adults of both insects. Data from the additional sites will strengthen our analysis of site characteristics and our evaluation of our monitoring techniques. We also continued to evaluate the impact of the two root feeding agents on knapweed at the selected 13 sites.

A final report will be produced during 1999 that will summarize our findings and describe the monitoring techniques that we have developed. If you have an interest or comments on the project please contact Nancy Sturdevant, (406) 329-3281 or Sandy Kegley, (208) 765-7355.

Evaluating the Use of Pheromones for Monitoring the Establishment of *Agapeta zoegana* (Lepidoptera: Tortricidae), a Biological Control Agent of Spotted Knapweed.

Very little work has been done on using pheromones to monitor beneficial insects such as *Agapeta zoegana* Haw., a biological control agent of spotted knapweed, *Centaurea maculosa* Lam. Spotted knapweed is a perennial aggressive weed that has invaded nearly three million hectares in nine western states and Canada, with over two million hectares invaded in Montana alone. Land managers have been releasing *A. zoegana* for spotted knapweed control over the past decade or more. However, at most of these sites, it is unknown if releases have become established, spread or are impacting the knapweed populations because of a lack of monitoring tools. The objective of our study was to evaluate the attractiveness of *A. zoegana* to four pheromone formulations at three field sites in Montana, and to evaluate pheromones as a monitoring tool for *A. zoegana* populations.

Three field locations were selected that had established populations of *A. zoegana.* Two sites were located on the Lolo NF; Valley of the Moons and Mormon Peak. The third site was located on the Flathead Indian Reservation, Garden Gulch.

The traps were checked at weekly intervals at each location. Number of *Agapeta* moths per trap were recorded. Following the last weekly inspection, the traps were collected and the total number of moths found was recorded.

A total of 396 moths were collected across all sites and all pheromone compounds. Only five moths were caught in the control traps. The highest number of moths were trapped at Mormon Peak. The results of this study show that there is great potential for using pheromones for monitoring the establishment of *A. zoegana* populations. Perhaps one of the greatest attributes of developing and using a pheromone based monitoring system is that very little training is required and sampling error should be very low.

This study has identified which of two pheromone compounds is more attractive to *A. zoegana* in Montana. The next step is to identify the strength of Z11-14Ac for monitoring objectives and to develop a prediction system that relates trap catches to actual population measurements and impact.

A report has been written and will be released in 1999. For more information on this project contact Nancy J. Sturdevant, (406) 329-3281.

Diseases

Annosum Root Disease Project on the Flathead Indian Reservation

A project was initiated in 1993 to follow the decline and mortality of large ponderosa pine. The 5-year remeasurement was completed in 1998. Preliminary results indicate tree crowns have improved over the last 5 years, and mortality has been consistently low (1-2 percent in trees 15 inches d.b.h. and larger). This observed improvement may be due to the trees recovering from the drought experienced in the area in the late 1980's. A 5-year report is being prepared and should be available in 1999.

Root Disease in Douglas-fir/Grand Fir Stands

We had a number of service requests this year to review Douglas-fir stands with root disease and Douglas-fir bark beetle. Douglas-fir bark beetle populations have been increasing in a number of areas in western Montana (see the bark beetle update within this condition report). Many area foresters want to do intermediate harvesting to reduce the risk from bark beetles, decrease the fuel load and improve the overall vigor of the leave trees.

Some very good data from northern Idaho on the effects of commercial harvesting in root-diseased Douglas-fir and grand fir have just recently become available. Although this data is from northern Idaho, we feel it is very applicable to Douglas-fir forests in western Montana. A set of permanent plots on the Fernan Ranger District, Idaho Panhandle National Forests (Lonesome Creek) was established in the 1970's and recently had a 20-year remeasurement. These plots were put in place to monitor the effects of commercial thinning in Douglas-fir and grand fir with root disease. The treatments were: (1) thinning and leaving the best trees with no bias towards species of leave trees, (2) thinning and leaving only non-Douglas-fir and grand fir; and (3) control (no thinning). Treatment one (thinning with no regard to species of leave trees) increased the overall mortality by volume, but not trees per acre. After the plots were harvested, the mortality was shifted to the leave trees. Grand fir volume increased after the thinning, but further analysis indicates the increase in volume was due to ingrowth. The average d.b.h of the grand fir decreased over time; big grand fir trees were dying but were being replaced by smaller ingrowth trees. The control plots had a decrease in volume of 24 percent over the 20 years, which was the same as treatment one. Treatment 2 (thinning the Douglas-fir and grand fir) had a 29 percent increase in volume over the 20 years. Below is a table that summarizes these results. For further information on this study, please contact Jim Byler, Region One Forest Health Protection, Coeur d'Alene Field Office, Idaho Panhandle NFs Supervisor's Office.

Lonesome Creek Commercial Thinning
Preliminary Results
1998

TREATMENT	START BA (after treatment)	END BA (20 years later)
Thin/leaving best	120	45 (- 63%)
DFGF	25	40 (+ 60%)
Other species	85	90 (+ 6%)
TOTAL	230	175 (- 24%)
TREATMENT		
Thin/leave non-DF/GF		
Other species	140	180 (+ 29%)
TREATMENT		
Control (no harvest)		
DF	150	80 (- 47%)
GF	75	50 (- 33%)
Other species	105	120 (+ 14%)
TOTAL	330	250 (- 24%)

Other

A Three-year Evaluation of the Effects of Chlorine on Douglas-fir and Ponderosa Pine Trees near Alberton, Montana

Chlorine was released after a Montana Rail Link train derailed on April 11, 1996 near Alberton, Montana. The effects of chlorine on ponderosa pine and Douglas-fir trees were evaluated at two sites between 1996 and 1998. Two areas were selected to establish plots. The first area was at the site of derailment, Ground Zero. The second area, Eddy Creek, was approximately 4 miles downwind and northeast of the derailment site. This site was selected based upon accessibility, tree damage and ownership. The short and long-term effects of the chlorine release on tree crowns and tree mortality were monitored. Incidence of insects and diseases following the spill were evaluated.

Mortality following the chlorine release has been confined to trees less than 3.0 inches diameter at breast height (d.b.h). Total crown damage of trees that have died averaged 95%, and ranged from 70 to 100%. All mortality occurred at the Ground Zero plot, and most mortality occurred during the first year following the chlorine release. Varying amounts of needle burning and needle loss were apparent at both the Eddy Creek and Ground Zero plots.

Results from this study indicate if crown damage is high enough (an average of 95 percent), mortality will likely occur in small ponderosa pine trees. There is insufficient data to draw any conclusions regarding the effects of high levels of chlorine exposure on small Douglas-fir. Only one small Douglas-fir (0-2.9" size class) was present at Ground Zero where most of the crown damage was recorded. A report detailing the study will be published as a Forest Service Technical Bulletin in 1999. For more information on this project, contact Nancy J. Sturdevant, (406) 329-3281 or Blakey Lockman, (406) 329-3189.

Limber Pine Evaluation Surveys

Decline and mortality of limber pine has been observed in various locations in eastern Montana for the past 4-5 years. Monitoring of the damage has resulted in the discovery of an association between severe defoliation from Dothistroma needle blight and the decline and mortality. There is now an effort underway to extend the survey of limber pine throughout eastern Montana and potentially into Wyoming and Colorado. The overall objective of the

project would be to evaluate the health of limber pine populations: what is the extent of the damage seen in parts of eastern Montana, does it occur in other states? What is the status of white pine blister rust, Dothistroma needle blight, and other damaging agents in various locations? Are there correlations between the decline and mortality with site factors such as habitat type, elevation, aspect, soils, characteristics, fire history, etc.? This project will potentially be a joint effort between Forest Health Protection staff in the Northern and Rocky Mountain Regions and may also include university cooperators.

APPENDIX

FOREST HEALTH PROTECTION PERSONNEL

Regional Office *Phone: (406) 329-3308*

Name	*Position*	*Ext*
Bill Boettcher	Director	3280
Dave Atkins	Forest Health Monitoring Coordinator	3134

USDA Forest Service, Northern Region, Federal Building,
200 East Broadway, P.O. Box 7669, Missoula, Montana 59807

Missoula Field Office *Phone: (406) 329-3308*

Gregg DeNitto	Group Leader	3637
Nancy Sturdevant	Entomologist	3281
Ken Gibson	Entomologist	3278
Bill Cramer	Bio. Science Technician	3130
Blakey Lockman	Plant Pathologist	3180
Tim McConnell	Bio. Science Technician, Aerial Survey	3136
Larry Stipe	Entomologist, GIS Coordinator	3289
Jane Taylor	Plant Pathologist	3463
Sue Hagle*	Plant Pathologist	3323
*Assigned to the Coeur d'Alene Field Office		
Terri Johnson	Computer Clerk	3298

USDA Forest Service, Northern Region, Federal Building,
200 East Broadway, P.O. Box 7669, Missoula, Montana 59807

Coeur d'Alene Field Office *Phone: (208) 765-7223*

Jim Byler	Group Leader	7342
Bob James	Plant Pathologist	7421
Sandy Kegley	Entomologist	7355
Darryl Jewett	Entomologist	7355
Carol Bell Randall	Entomologist	7343
John Schwandt	Plant Pathologist	7415
Doug Wulff	Bio. Science Technician	7344

USDA Forest Service, Northern Region, Idaho Panhandle National Forest,
3815 Schreiber Way, Coeur d'Alene, Idaho 83814-8363

State Forest Pest Management Personnel

Montana Department of Natural Resources *Phone: (406) 542-4300*

Don Artley	State Forester	
Chris Tootel	Chief, Service Forestry Bureau	
Steve Kohler	Forest Pest Management Specialist	4238

Montana Department of Natural Resources and Conservation, Forestry Division
2705 Spurgin Road, Missoula, Montana 59804

COMMON AND SCIENTIFIC NAMES

Diseases

Annosum root disease	*Heterobasidion annosum* (Fr.) Bref.	Primary hosts: DF, GF, PP, SAF
Armillaria root disease	*Armillaria ostoyae* (Romagn.) *Herink*	DF, GF, SAF, sapling pines
Atropellis canker	*Atropellis piniphila* (Weir) Lohn. and Cash	LPP
Brown cubical butt rot	*Phaeolus schweinitzii* (Fr.) Pat.	DF
Comandra rust	*Cronartium comandra* Peck.	LPP, PP
Diplodia blight	*Sphaeropsis sapinea* (Fr.) Dyko.	PP
Dutch elm disease	*Ceratocystis ulmi* (Buism.)	American elm
Dwarf mistletoes	*Arceuthobium* spp.	LPP, DF, WL
Brown stingy rot	*Echinodontium tinctorium*	GF, WH
Elytroderma needle cast	*Elytroderma deformans* (Weir) Darker	PP
Fusarium root rot	*Fusarium oxysporum* Schlect.	DF (Nursery)
Grey mold	*Botrytis cinerea* Pers. Ex Fr.	WL (Nursery)
Larch needle blight	*Hypodermella laricis* Tub.	WL
Larch needle cast	*Meria laricis* Vuill.	WL
Laminated root rot	*Phellinus weirii* (Murr.) Gilb.	DF, GF, WH, SAF
Lodgepole pine needle cast	*Lophodermella concolor* (Dear.) Dark	LPP
Pini rot	*Phellinus pini* (Thore:Fr.) Pilet.	DF, WL, ES, All pines
Sirococcus tip blight	*Sirococcus strobilinus* Preuss	WWP (Nursery)
Swiss needle cast	*Phaeocryptopus gaeumannii* (Rhode)	DF
Western gall rust	*Endocronartium harknessii* (Moore) Hirta.	LPP, PP
White pine blister rust	*Cronartium ribicola* Fisch.	WWP, WBP
Rhabdocline needle cast	*Rhabdocline pseudotsugae* Syd.	DF

Insects

Douglas-fir beetle	*Dendroctonus pseudotsugae* Hopkins	DF
Douglas-fir tussock moth	*Orygia pseudotsugata* (McDunnough)	DF, TF, ES
Gypsy moth	*Lymantria dispar* (Linnaeus)	Most hardwoods
Mountain pine beetle	*Dendroctonus ponderosae* Hopkins	All pines
Pine engraver beetle	*Ips pini* (Say)	PP, LPP
Spruce beetle	*Dendroctonus rufipennis* (Kirby)	ES
Western balsam bark beetle	*Dryocoetes confusis* Swaine	SAF
Western spruce budworm	*Choristoneura occidentalis* Freeman	DF, TF, ES, WI
Western pine beetle	*Dendroctonus brevicomis* LeConte	PP
Fir engraver beetle	*Scolytis ventralis* LeConte	GF, SAF
Lodgepole terminal weevil	*Pissodes terminalis* Hopping	LPP
Balsam woolly adelgis	*Adelges piceae* (Ratzeburg)	SAF, GF
Pine tussock moth	*Dasychira plagiata*	PP
Sawflies	*Neodiprion autumnalis*	PP
Tip moth	*Rhyacionia species*	PP

DF = Douglas-fir; GF = Grand fir; TF = True fir; SAF = Subalpine fir; PP = Ponderosa pine; LPP = Lodgepole pine; WWP = Western white pine; ES = Engelmann spruce; WH = Western hemlock; WL = Western larch; MH = Most hardwoods; WRC = Western redcedar; WBP = Whitebark pine

PUBLICATIONS

Dumroese, R.K., R.L. James, and D.L. Wenny. 1995. Interactions between copper-coated containers and Fusarium root disease: a preliminary report. USDA Forest Service, Northern Region, Insect and Disease Management. Report 95-9, 8 pp.

Dumroese, R.K., R.L. James, and D.L. Wenny. 1996. *Gliocladium virens* in an alginate prill ineffective as a biological control of Fusarium root disease in container-grown Douglas-fir. New Forests 12:113-124.

Dumroese, R.K., R.L. James and D.L. Wenny. 1998. Interactions among *Streptomyces griseoviradis, Fusarium* root disease, and Douglas-fir seedlings. New Forests 15:181-191.

James, R.L. 1994. Fungi carried by adult fungus gnats (Diptera: Sciaridae) in Idaho greenhouses. USDA Forest Service, Northern Region, Forest Pest Management, Rept. 94-5, 10 pp.

James, R.L. 1994. Melampsora rust on container-grown western larch seedlings Raintree Nursery, Libby, Montana. USDA Forest Service, Northern Region, Forest pest Management, Nursery Disease Notes No. 131, 5 pp.

James, R.L. and T. Finnerty. 1994. Rhizophaera needle cast of Colorado blue spruce in northern Idaho. USDA Forest Service, Northern Region, Forest Pest Management, Rept. 94-7, 6 pp.

James, R.L., D.M. Hildebrand, S.J. Frankel, M.M. Cram, and J.G. O'Brien. 1994. Alternative technologies for management of soil-borne diseases in bareroot forest nurseries in the United States. *In:* Landis, T.D. (tech. coord.). Proceedings: Northeastern and Intermountain Forest and Conservation Nursery Associations. USDA Forest Service, Gen. Tech. Rept. RM-243, pp. 91-96.

James, R.L. 1995. Fungi on Douglas-fir and ponderosa pine cones from the USDA Forest Service, Northern Region, Insect and Disease Management, Rept. 95-5, 8 pp.

James, R.L. 1995. Root diseases of western white pine transplants - USDA Forest Service Nursery, Coeur d'Alene, Idaho. USDA Forest Service, Northern Region, Insect and Disease Management, Rept 95-8, 10 pp.

James, R.L., R.K. Dumroese, and D.L. Wenny. 1995. Management of fungal diseases of western larch seed and seedlings. *In:* Schmidt, W.C. and K.J.

James, R.L., R.K. Dumroese, and D.L. Wenny. 1995. Botrytis cinerea carried by adult fungus gnats (Diptera:Sciaridae) in container nurseries. Tree Planters' Notes 46(2):48-53.

James, R.L., R.K. Dumroese, and D.L. Wenny. 1995. Fusarium proliferatum is a common, aggressive pathogen of container-grown conifer seedlings. Phytopatholgy 85(10):1129.

James, R.L. 1996. Root disease of 1-0 bareroot seedlings - USDA Forest Service Lucky Peak Nursery, Boise, Idaho. USDA Forest Service, Northern Region, Forest Health Protection. Report 96-4, 10 pp.

James, R.L., R.K. Dumroese, and C.J. Gilligan. 1996. Western white pine seedling mortality - USDA Forest Service Nursery, Coeur d'Alene, Idaho. USDA Forest Service, Northern Region, Forest Health Protection, Rept. 96-6, 10 pp.

James, R.L., R.K. Dumroese, and D.L. Wenny. 1996. Western larch seed - contaminating fungi and treatments to reduce infection and improve germination. USDA Forest Service, Northern Region, Forest Health Protection, Rept. 96-7, 14 pp.

James, R.L., D.S. Page-Dumroese, S.K. Kimball, and S. Omi. 1996. Effects of Brassica cover crop, organic amendment, fallowing, and soil fumigation on production of bareroot Douglas-fir seedlings - USDA Forest Service Nursery, Coeur d'Alene, Idaho. USDA Forest Service, Northern Region, Forest Health Protection, Rept. 96-5, 16 pp.

James, R.L. 1997. A short review of Fusarium section Liseola: implications for conifer seedling production. *In*: James, R.L. (editor). Proceedings of the third meeting of IUFRO Working Party S7.03-04 (diseases and Insects in Forest Nurseries). USDA Forest Service, Northern Region, Forest Health Protection. Report 97-4, pp 34-41.

James, R.L. 1997. Effects of fertilizer on selected potential plant pathogens in bareroot forest nurseries. *In*: Haase, D.L. and R. Rose (editors). Symposium proceedings: Forest Seedling Nutrition from the Nursery to the Field. Nursery Technology Cooperative, Oregon State University, Corvallis, OR, pp. 27-39.

James, R.L. 1997. Phytophthora root disease of bareroot Douglas-fir seedlings - USDA Forest Service Lucky Peak Nursery, Boise, Idaho. USDA Forest Service, Northern Region, Forest Health Protection. Nursery Diseases Notes No. 134, 6 pp.

James, R.L. 1997. (editor). Proceedings of the third meeting of IUFRO Working Party S7.03-04 (Diseases and Insects in Forest Nurseries). USDA Forest Service, Northern Region, Forest Health Protection. Report 97-4, 156 pp.

James, R.L., R.K. Dumroese, and D.L. Wenny. 1997. Pathogenicity of Fusarium proliferatum in container-grown Douglas-fir seedlings. *In*: James, R.L. (editor). Proceedings of the third meeting of IUFRO Working Party S7.03-04 (Diseases and Insects in Forest Nurseries). USDA Forest Service, Northern Region, Forest Health Protection, Report 97-4, pp. 26-33.

James, R.L. and K. Eggleston. 1997. Hot water treatments of plastic and styrofoam containers - USDA Forest Service Nursery, Coeur d'Alene, Idaho. USDA Forest Service, Northern Region, Forest Health Protection. Nursery Disease Notes No. 133, 10 pp.

James, R.L., J.K. Stone, D.M. Hildebrand, S.M. Frankel, and D.S. Gemandt. 1997. Alternatives to chemical soil fumigation in western federal bareroot conifer nurseries. *In*: Proceedings: 1997 Annual International Research Conference on Methyl Bromide Alternatives and Emissions Reductions. Methyl Bromide Alternatives Outreach. USEPA, USDA, pp. 25-1 - 25-2.

Kegley, S.J., L.Stipe, and C. Hepner. 1994. Tip moth control at the Lenore tree improvement area 1993. USDA Forest Service, Northern Region, Timber Cooperative Forestry and pest Management, Rept. 94-4.

Kegley, S. and N.J. Campbell. 1994. Preliminary findings of whitebark pine cone and seed insect survey. Nutcracker Notes November 10, No. 4, U.S. Forest Service, Intermountain Research Station, INT.

Kegley, S. and N.J. Campbell. 1997. Cone and seed insects affecting whitebark pine. Nutcracker Notes May 30, No. 8. U.S. Forest Service, Intermountain Station, INT.

Klein, W.H. and N.J. Campbell. 1995. Winter damage to the forests of Montana-Final Report. USDA Forest Service

McConnell, Tim, Ken Gibson, Blakey Lockman Nancy Campbell, Jane Taylor, Bob James, Sandy Kegley, Carol Randall, and Don Berg, Northern Region Insect and Disease Management, Steve Kohler, Montana Department of State Lands, Forestry Division. 1994. Montana forest insect and disease conditions and program highlights, 1994. USDA Forest Service, Northern Region, Insect and Disease Management, Rept. 95-2, 25 pp.

McConnell, Tim, Ken Gibson, Blakey Lockman Nancy Campbell, Bob James, Sandy Kegley, Carol Bell Randall, Northern Region Insect and Disease Management, Steve Kohler, Montana Department of State Lands, Forestry Division. 1995. Montana forest insect and disease conditions and program highlights, 1995. USDA Forest Service, Northern Region, Insect and Disease Management, Rept. 96-2, 29 pp.

McConnell, Tim, Ken Gibson, Blakey Lockman Nancy Campbell, Jane Taylor, Bob James, Sandy Kegley, Carol Randall, Northern Region Insect and Disease Management, Steve Kohler, Montana Department of State Lands, Forestry Division. 1996. Montana forest insect and disease conditions and program highlights, 1996. USDA Forest Service, Northern Region, Insect and Disease Management, Rept. 97-2, 27 pp.

McConnell, Tim, Ken Gibson, Blakey Lockman Nancy Sturdevant Jane Taylor, Don Berg, Gary Little, Bob James, Sandy Kegley, Carol Randall, Northern Region, Cooperative Forestry and Forest Health Protection; Steve Kohler, Montana Department of Natural Resources and Conservation, Forestry Division. 1997. Montana forest insect and disease conditions and program highlights, 1997. USDA Forest Service, Northern Region, Forest Health Protection, Rept. 98-2, 29 pp.

McDonald (compilers). Ecology and Management of *Larix* forests: A Look Ahead. Proceedings of an international symposium. USDA Forest Serviced, Intermountain Research Station, Gen. Tech. Rept. GTR-INT-319, pp. 300-306.

Mosseaux, M.R., R.K. Dumroese, R.L. James, D.L. Wenny and G.R. Knudsen. 1998. Efficacy of *Trichoderma harzianum* as a biological control of *Fusarium oxysporum* in container-grown Douglas-fir seedlings. New Forests 15:11-21.Rogers, Dan, Nancy Sturdevant, and Helen Atthowe. Winter injury in Montana landscapes. Missoula County Integrated Plant Management Factsheet No. 6.

Taylor, J.E. and J.W. Schwandt. 1998. Dothistroma needle blight of limber pine in Montana. USDA Forest Service, Forest Health Protection Rpt. 98-4. Missoula, MT. 7p.

Taylor, J.E. and N.J. Sturdevant. 1998. Limber pine mortality on the Lewis and Clark National Forest, Montana. USDA Forest Service, Forest Health Protection Rpt. 98-5. Missoula, MT. 4p.